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**Visual display apparatus.**

Visual display apparatus comprises movable display elements E mounted in space between a transparent glass screen G and a magnetizable sheet M. The individually movable elements E are resiliently urged to advance positions in which they abut the screen G but can be held in withdrawn positions by magnetised spots printed on to the magnetizable sheet M, the elements being of a soft magnetic material. The elements are immersed in an opaque fluid by which they are masked from view when in their withdrawn positions. A pattern-writing carriage is arranged to traverse the sheet M, writing any required pattern of magnetized spots on to the sheet, in order to establish a corresponding arrangement of the elements E.

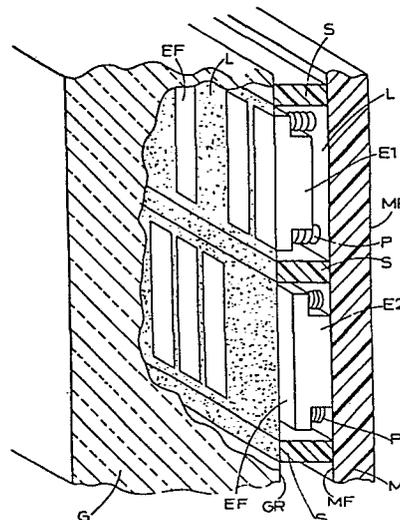


FIG 2

VISUAL DISPLAY APPARATUS

This invention is concerned with visual display apparatus comprising a transparent screen, display-presenting means arranged behind the screen to present a display which can be viewed through the screen, and display-setting means whereby in use of the apparatus said display-presenting means can be rearranged to vary the display presented, said display-presenting means comprising a plurality of display elements which are each movable under the control of said display-setting means between an advanced position adjacent a rear face of the screen and a withdrawn position, relatively remote from said rear face, each of said elements being visible through the screen when in its advanced position but not when in its withdrawn position.

In many circumstances there is a requirement for apparatus which can present information visually and be readily re-programmed as required to present different information. Commonly such apparatus finds use in association with a computer which stores, and can update, a large volume of information, the apparatus enabling a selected portion of that volume of information to be presented visually. The most common form of visual display apparatus comprises a cathode ray tube for presenting the display, though especially for use in public places (e.g. railway stations and airports) where a very large presentation is required various other kinds of apparatus have been used. For example remotely-operated display boards have been used at railway stations which comprise a large number of printed strips bearing standard information about services, a certain selection of strips being presented in combination as required.

The use of a cathode ray tube has generally provided much the most versatile kind of visual display apparatus, since there is virtually no limit to the variety of information which can be presented. However, a practical problem can arise concerning the amount of information which can be presented in this manner at any one time, owing to the limits on the practical size for the screen and on the resolution obtainable in forming the image on the screen.

There have been proposed in U.K. Patent Specifications Nos. 990 094 and 1 533 458 visual display devices of the kind comprising a plurality of display elements which can be individually moved between advanced positions, in which they are visible through a front screen, and retracted positions in which they are withdrawn from the screen and out of view. Variable information, presented as characters made up from selected elements, can be displayed through the screen by selecting which elements are moved to their advanced positions.

Specification No. 990 094 describes a device which may advantageously be used as an on-line visual output indication. The display elements are provided as cylindrical heads on pistons which slide in bores in a block, the heads being in a space between the block and a transparent plate. The heads are surrounded in the space by an opaque fluid, in order that they are masked from view by the fluid when in their retracted positions but are clearly visible when in their advanced positions against a face of the screen. The elements are continuously urged towards their retracted positions by pressure in the fluid in the space, and are advanced as required by means of pressure applied behind the pistons. A complicated hydraulic network enables fluid pressure to be applied selectively to the pistons as required.

Specification No. 1 533 458 describes various devices in which the positions of display elements are controlled by means of electrostatic forces. In some of the arrangements the display elements are immersed in an opaque liquid, and in others the elements are in air and become hidden from view, in their retracted positions, by means other than masking by fluid. The devices operate on a bi-stable principle and are arranged to be cross bar addressed.

The devices described in specifications Nos. 990 094 and 1 533 458 all suffer from certain disadvantages. In particular, in each case a complicated addressing network is required, in one case hydraulic, and electrical for the others. Furthermore, at least in the case of the device described in the latter specification, the information displayed at any time is dependent upon a continuing power supply, and should the power supply be interrupted the image will be lost.

It is an object of the present invention to provide improved visual display apparatus which overcomes these drawbacks and in accordance with the invention visual display apparatus is characterised in that the display-setting means comprises pattern-retaining means on to which a magnetic pattern can be written, and pattern-writing means by means of which the pattern required to establish a predetermined display can be written on to the pattern-retaining means, the display elements being magnetically responsive in order that their dispositions are determined by a pattern on the pattern-retaining means.

In use of the apparatus, what display is presented will depend upon which of the display elements are set

in their advanced positions. The display elements may be arranged to form abstract patterns or pictures, but it is anticipated that the most usual use for the apparatus would be in the presentation of information in a written form. Whilst the display elements could be much larger, an apparatus in which the elements comprise a display surface having an area of less than  $0.5 \text{ mm}^2$  may find wide application. Such small display elements may be created by means of photo-etching techniques.

The display elements are preferably uniformly spaced apart in straight rows or columns, there being a plurality of such rows or columns arranged parallel to one another.

Preferably, the elements are mounted in such a manner that they are continuously resiliently urged towards one of their advanced and withdrawn positions, and comprise soft magnetic material, the arrangement being such that a magnetized spot printed on to the pattern-retaining means opposite an element can cause the element to move to the other of its positions. The elements may most conveniently be resiliently urged towards their advanced positions, a magnetized spot on the pattern-retaining means serving to move an element to its withdrawn position.

Pattern-writing means of the apparatus can comprise a carriage arranged to traverse the pattern-retaining means. The carriage may bear two arrays of electromagnets, arranged in a similar manner to those of a conventional tape recorder, one of the arrays being for the purpose of erasing spots of an existing pattern on the pattern-retaining means and the other being for the purpose of writing fresh spots in the creation of a new pattern. The carriage may be arranged to travel linear-

ly along paths parallel to rows or columns of the display elements, and to be traversed between the rows or columns.

There now follows a description, to be read with reference to the accompanying drawings, of visual display apparatus which illustrates the invention by way of example.

In the accompanying drawings:-

Figure 1 is a perspective view of the apparatus as a whole, with a portion of a front screen and imaging layer cut away to reveal a pattern-writing carriage;

Figure 2 illustrates the construction of a portion of the front screen and imaging layer to a much larger scale than Figure 1;

Figure 3 is a view in plan of the carriage;

Figure 4 is a view in elevation of the carriage in one mode of operation between the imaging layer and a back plate;

Figure 5 is a view similar to Figure 4 but showing the carriage in a second mode of operation; and

Figure 6 illustrates an alternative construction of imaging layer.

The apparatus enables computer-held information to be displayed on a large flat screen. A large amount of data can be displayed at one time.

As shown in Figures 1 and 2, the apparatus comprises a flat transparent sheet of glass G, providing a front screen, and an imaging layer arranged behind the screen and comprising display-presenting means arranged to present a display which can be viewed through the screen G. The imaging layer I comprises also a magnetizable sheet M of display-setting means whereby the display-presenting means can be rearranged as required to vary the display presented.

The magnetizable sheet M of the imaging layer is mounted parallel to the front screen G by means of, and at a distance determined by, spacers S. A flat rear face GR of the screen G, a flat front face MF of the sheet M, and the spacers S together define a plurality of parallel elongate chambers in each of which is mounted a straight row of uniformly spaced apart display elements E. Each of the display elements E is mounted in a manner which allows it to move between an advanced position (shown by element E1 in Figure 2) adjacent the rear face GR of the screen G, and a withdrawn position (shown by element E2), relatively remote from the rear face GR of the screen, adjacent the front face MF of the magnetizable sheet M. Each element E is mounted by means of resilient mountings P which continuously urge the element towards its advanced position. Each element E comprises a flat, oblong rectangular, display face EF which in the advanced position of the element lies against the rear face GR of the screen G. The display face EF of each of the elements has a surface area of approximately  $0.33 \text{ mm}^2$ , and there is a very large number of elements spread through the imaging layer as a whole.

Each of the display elements E is immersed in an opaque liquid L which is of a colour which contrasts

markedly with that of the display face EF of the element; the liquid L is black and the faces EF white, through other means of giving contrasting appearances could be employed in other apparatuses according to the invention.

Each of the display elements E is of a soft magnetic material, being a ferrite and plastics composite material. This enables magnetic forces to be employed to move selected elements from their advanced positions, to which they are otherwise urged by their mountings P, to their withdrawn positions. Accordingly, by means of a pattern of magnetized spots on the sheet M, each spot being opposite an element E, a predetermined arrangement of the elements E can be established.

The display-setting means comprises pattern-retaining means, in the form of the magnetizable sheet M, pattern-writing means comprising a movable carriage C, and a control unit U which is connected to the carriage C by means of a flexible cable K and which can be linked to a computer in which information to be displayed is stored. The carriage C is arranged to travel along paths parallel to the rows of display elements E writing magnetized spots on to the sheet M opposite selected elements E. Accordingly a required pattern of magnetized spots can be written on to the sheet M, by means of the carriage C operating under the control unit U, to establish a predetermined arrangement of elements E, those elements which do not have a spot opposite them remaining in their advanced positions and the elements which do have a spot opposite them being drawn to, and held in, their withdrawn positions.

The construction of the carriage C is shown in Figures 3 to 5. The carriage is arranged to run on

wheels on a rear face MR of the magnetizable sheet M of the imaging layer. The carriage comprises two wheeled frames, a main frame F1 carrying four wheels ZW by means of which the carriage can run along writing paths parallel to the rows of display elements E, and a sub-frame F2 carrying four wheels VW by means of which the carriage can be traversed between writing paths by movements in directions perpendicular to the writing paths. The sub-frame F2 is pivotally mounted at T for movements under the control of an actuator A between a raised position (Figure 5) in which its wheels VW are clear of the sheet M and the carriage rests on the wheels ZW of the main frame F1, and a lowered position (Figure 4) in which the carriage rests on the wheels VW, with the wheels ZW of the main frame F1 clear of the sheet M. In order to drive the carriage in each of its two possible modes, the main frame F1 carries a driving unit VD, arranged to drive the carriage when the carriage is standing on the wheels VW of the sub-frame F2, and the sub-frame F2 carries a driving unit ZD arranged to drive the carriage when the carriage is standing on the wheels ZW of the main frame F1. Each of the driving units comprises a driving wheel arranged to engage frictionally a back plate B of the apparatus which is mounted parallel to the sheet M.

Mounted on the main frame F1 of the carriage are two arrays of electromagnets, which provide a write head of the carriage by means of which magnetized spots can be written on to, and erased from, the magnetizable sheet M of the imaging layer I. The array HE is arranged to erase and the array HW is arranged to write, in a similar manner to a write head of a conventional magnetic tape recorder.

Positioning of the carriage C is controlled by means of photoelectric detection from position lines (not shown) drawn on the back plate B, which enable the control unit U to instruct suitable steering and movement control actions. In other apparatus according to the invention, a carriage might be physically located in the writing paths by means of wheel tracks.

Since each of the display elements E contrasts in appearance with the liquid L in which it is immersed, an element in its advanced position, such as the element E1, appears to a viewer looking through the glass screen G as a white dot in a black background. However, since the liquid L is opaque, when an element is in its withdrawn position, such as the element E2, it is screened from view by the liquid. Upon moving an element from its withdrawn to its advanced position, the liquid is substantially wholly displaced from the display face EF of the element owing to its engagement with the rear face GR of the screen. Accordingly, a pattern of visible dots can be caused to appear on the screen G by writing an appropriate pattern of magnetized spots on to the sheet M. These patterns of visible dots can be a conventional dot-matrix representation of alphanumeric characters. The display will remain on the screen until revision of the magnetic pattern on the sheet M, even in the event of a power failure.

In Figure 6 is shown an alternative construction for an imaging layer of an apparatus according to the invention. Instead of display elements E being individually mounted by means of resilient mountings, all the elements in one row are mounted on a resilient diaphragm D and the elements are urged to their advanced positions by a small difference in hydraulic pressure between the two sides of the diaphragm.

As a further alternative, the resilience of the diaphragm alone could be employed to urge the elements towards one of their advanced and withdrawn positions, without the use of a hydraulic pressure difference.

CLAIMS

1. Visual display apparatus comprising a transparent screen (G), display-presenting means (E, L) arranged behind the screen to present a display which can be viewed through the screen, and display-setting means (M, C) whereby in use of the apparatus said display-presenting means can be rearranged to vary the display presented, said display-presenting means comprising a plurality of display elements (E) which are each movable under the control of said display-setting means between an advanced position adjacent a rear face (GR) of the screen and a withdrawn position, relatively remote from said rear face, each of said elements being visible through the screen when in its advanced position but not when in its withdrawn position, characterised in that the display-setting means comprises pattern-retaining means (M) on to which a magnetic pattern can be written, and pattern-writing means (C) by means of which the pattern required to establish a predetermined display can be written on to the pattern-retaining means, the display elements (E) being magnetically responsive in order that their dispositions are determined by a pattern on the pattern-retaining means.

2. Apparatus according to claim 1 characterised in that the elements (E) comprise soft magnetic material and are mounted in such a manner that they are continuously resiliently urged towards one of their advanced and withdrawn positions, the arrangement being such that a magnetized spot printed on to the pattern-retaining means opposite an element can cause the element to move to the other of its positions.

3. Apparatus according to claim 2 characterised in that the display elements (E) are individually mounted by means of resilient mountings (P).

4. Apparatus according to claim 2 characterised in that a plurality of elements (E) is mounted on a resilient diaphragm (D).

5. Apparatus according to claim 4 characterised in that the elements (E) are continuously urged towards one of their advanced and withdrawn positions by a difference in hydraulic pressure between the two sides of the diaphragm.

6. Apparatus according to claim 1 characterised in that said pattern-writing means (C) comprises a carriage arranged to traverse the pattern-retaining means (M).

7. Apparatus according to claim 6 characterised in that said carriage (C) bears two electromagnetic arrays, one of the arrays (HE) being for the purpose of erasing spots of an existing pattern on the pattern-retaining means (M) and the other (HW) being for the purpose of writing fresh spots in the creation of a new pattern.

8. Apparatus according to either of claims 6 and 7 characterised in that the carriage (C) comprises two wheeled frames (F1, F2) arranged to give two degrees of freedom of movement, the carriage running on one or the other set of wheels at a time to travel either along a writing path parallel to a row or column of display elements, or along a traversing path between rows or columns.

9. Apparatus according to claim 8 characterised in that engagement of one or the other set of wheels can be

effected by means of a pivotal movement of one frame relative to the other.

10. Apparatus according to any one of claims 1 to 9 characterised in that each of the display elements (E) is immersed in a liquid (L) with which it contrasts in appearance, and is screened from view by the liquid when in its withdrawn position.



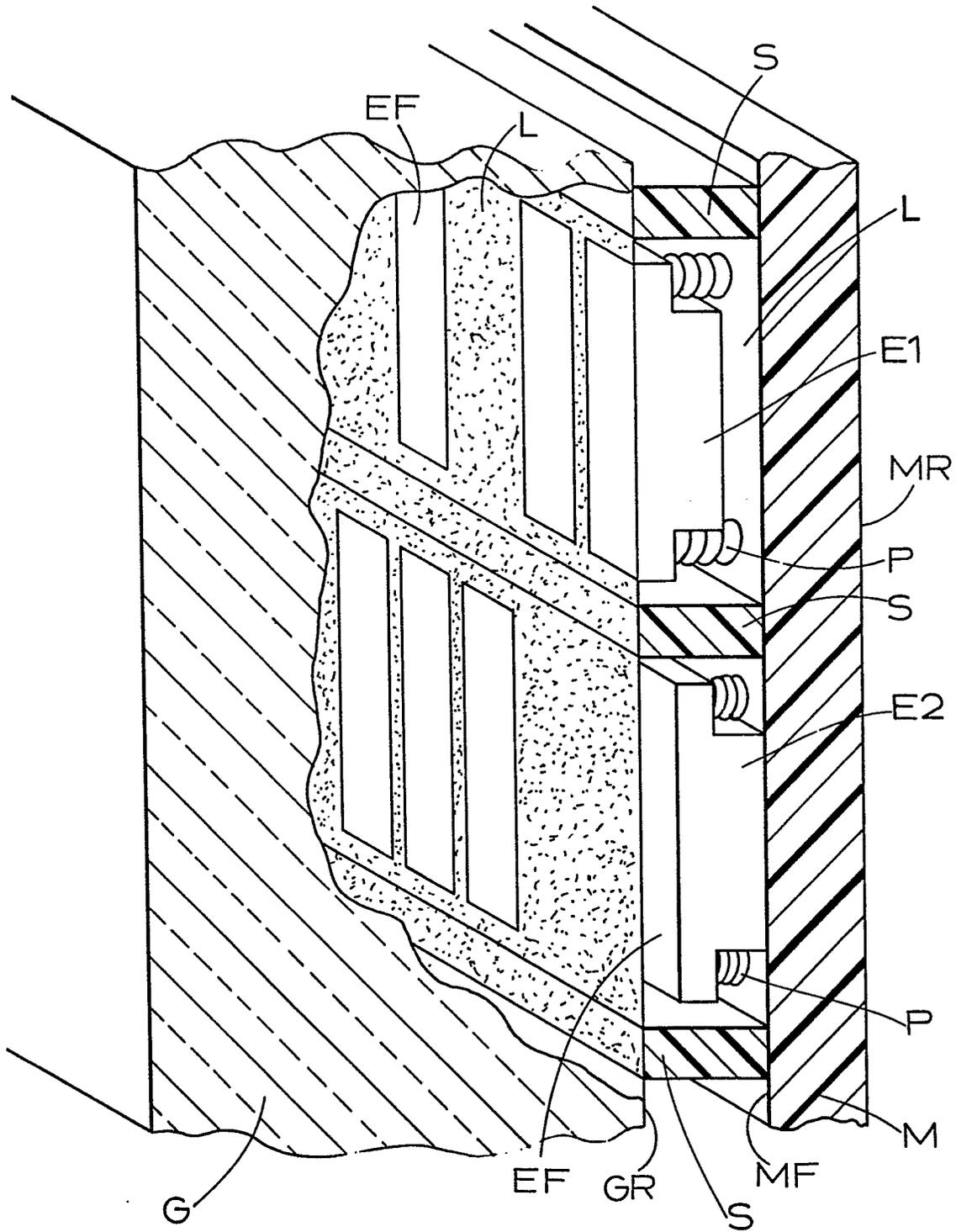


FIG. 2.

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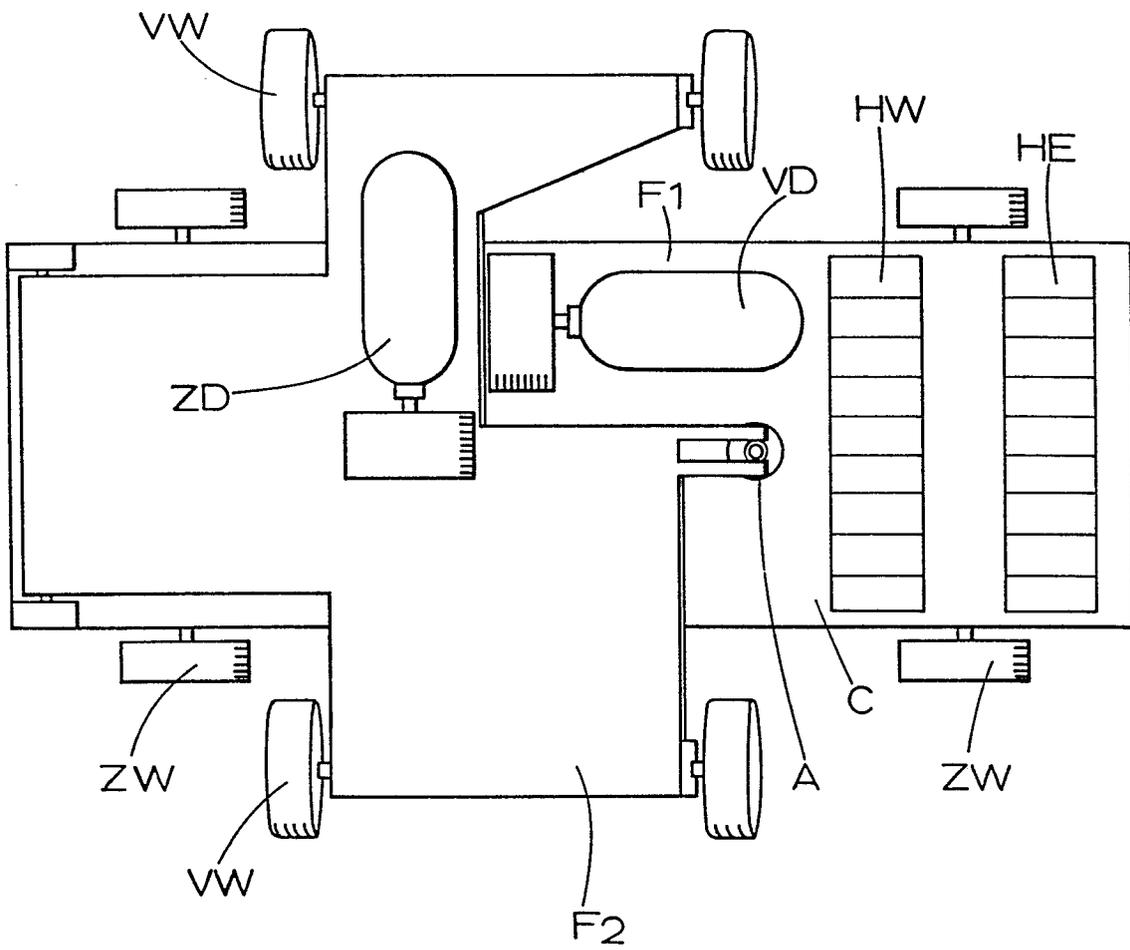


FIG. 3.

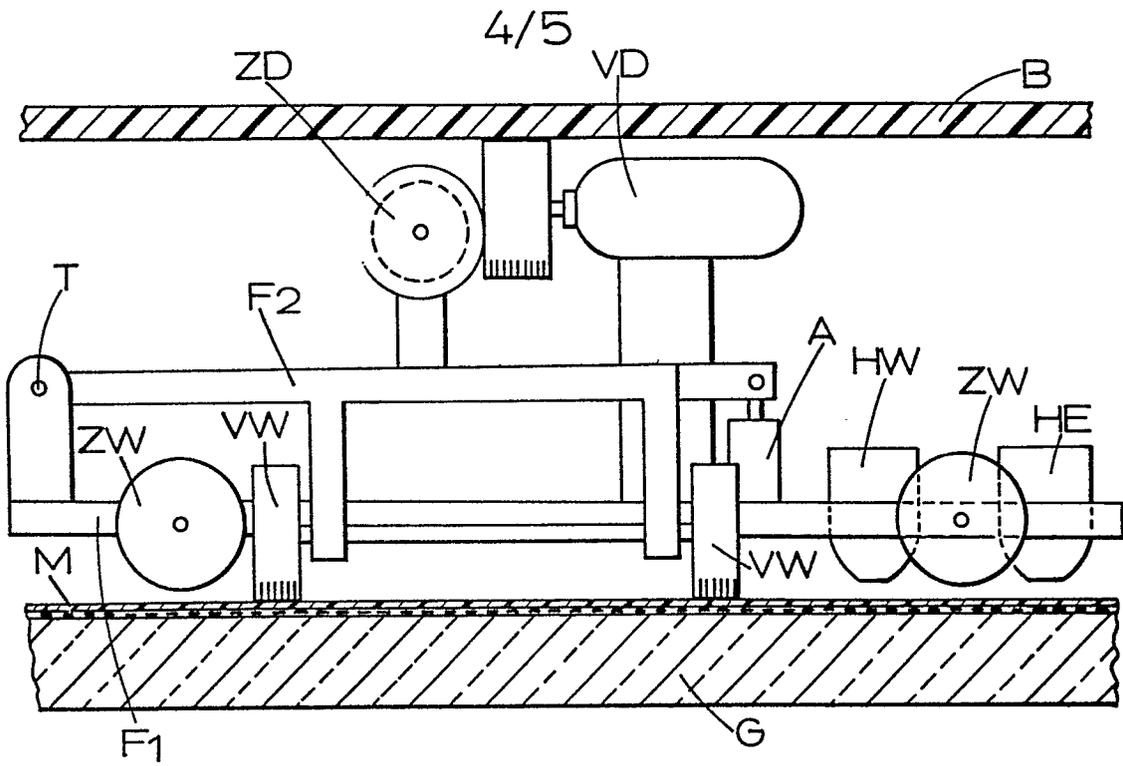


FIG. 4.

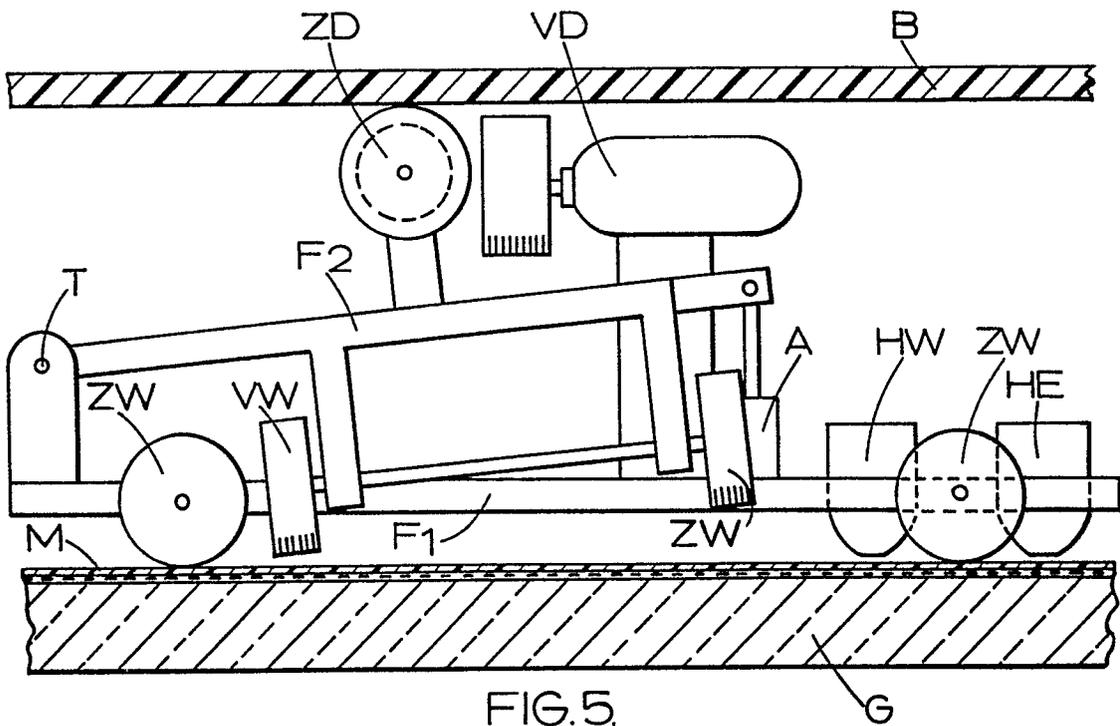


FIG. 5.

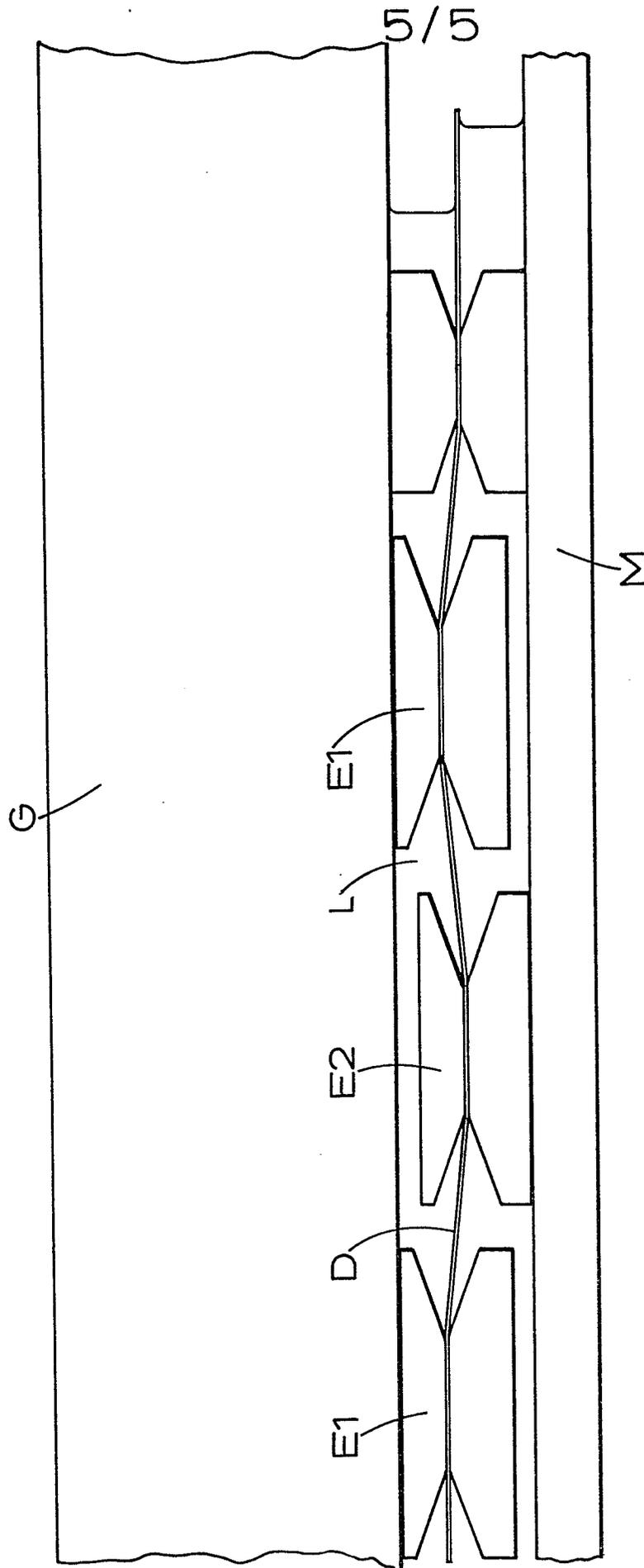


FIG. 6.



DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. <sup>3</sup> )
X	US-A-3 812 490 (THE BENDIX CORPORATION) *Claims 1-3,6-8,14; column 2, lines 38-67; column 5, lines 28-45; figures 1-5*	1-2,4,10	G 09 F 9/37
A	--- US-A-3 106 794 (SOCIETE D'ELECTRICITE MORS) *Claims 1-2,7,9; column 3, lines 3-22; figures 1-6*	1,6,10	
A	--- FR-A-2 307 414 (THE MAGNA VOX COMPANY) *Claims 1-2,6; figures 1A-1B*	1-2	
A	--- FR-A-1 460 598 (CONTRAVES A.G) *Abstract 1-3; page 2, left-hand column, last paragraph; figures 1-3*	1,4	
			TECHNICAL FIELDS SEARCHED (Int. Cl. <sup>3</sup> )
			G 09 F
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 27-09-1982	Examiner FRANSEN L.J.L.
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		& : member of the same patent family, corresponding document	